

**[SPECIFICATION]**

**[TITLE OF THE INVENTION]**

METHOD OF WINDING COIL AND TRANSFORMER AND INVERTER FOR LIQUID  
CRYSTAL DISPLAY HAVING COIL WOUND USING THE SAME

**[BRIEF DESCRIPTION OF THE DRAWINGS]**

Fig. 1 is an exploded perspective view showing a structure of a transformer for a lamp driving circuit of a conventional liquid crystal display;

Fig. 2 is a perspective view of the transformer shown in Fig. 1;

Fig. 3 is a sectional view for showing a winding method in the transformer shown in Fig. 1;

Fig. 4 is a sectional view for showing a winding method in the transformer shown in Fig. 1 in detail;

Fig. 5 is an exploded perspective view showing a structure of a transformer for a lamp driving circuit of a liquid crystal display according to a first embodiment of the present invention;

Fig. 6 is a perspective view of the transformer shown in Fig. 5;

Fig. 7 is a sectional view for showing a winding method in the transformer shown in Fig. 5;

Fig. 8 is a sectional view for showing a winding method

in the transformer shown in Fig. 5 in detail;

Fig. 9 is a sectional view for showing a winding method in a transformer of a lamp driving circuit of a liquid crystal display according to a second embodiment of the present invention;

Fig. 10 is a sectional view for showing a winding method in a transformer of a lamp driving circuit of a liquid crystal display according to a third embodiment of the present invention;

Fig. 11 is a sectional view for showing a method of winding each of the coil blocks shown in Fig. 10;

Fig. 12 is a schematic block diagram showing a configuration of an inverter for a liquid crystal display according to an embodiment of the present invention;

Fig. 13 is a detailed circuit diagram of the DC/AC converter shown in Fig. 12; and

Fig. 14A to Fig. 14D are waveform diagrams of voltage signals detected at each node of the DC/AC converter shown in Fig. 13.

#### **<DETAILED DESCRIPTION OF THE REFERENCE NUMERALS>**

1, 22, 22, 32: bobbin

1a: barrier rib

2, 12: coil

2a: coil going over a barrier rib

3, 13: lead pin

4, 14, 24, 34: ferrite core

5a, 5b, 5c, 15, 25, 35: coil winding part

36: coil block

42: DC/DC converter

44: DC/AC converter

**[DETAILED DESCRIPTION OF THE INVENTION]**

**[OBJECT OF THE INVENTION]**

**[TECHNICAL FIELD INCLUDING THE INVENTION AND PRIOR ART THEREIN]**

This invention relates to a transformer for a lamp driving circuit of a liquid crystal display, and more particularly to a coil winding method that is adaptive for reducing a power loss and a transformer having a coil wound using the same. The present invention also is directed to an inverter for a liquid crystal display that is capable of reducing a power loss.

Generally, a liquid crystal display (LCD) of active matrix driving system uses thin film transistors (TFT's) as switching devices to display a natural moving picture. Since such a LCD can be made into a smaller device in size than the existent Brown tube, it has been widely used for a monitor for a personal computer or a notebook computer as well as an office automation equipment such as a copy machine, etc., and a portable equipment such as a cellular phone and a pager, etc.

Such a LCD requires a light source such as a backlight because it is not a self light-emitting display device. The backlight is driven with an inverter and consumes the greatest power in the LCD devices.

The inverter driving the backlight is largely divided into a DC/DC converter and a DC/AC converter.

The DC/DC converter generates a DC voltage using a pulse width modulation (PWM).

The DC/AC converter plays a role to convert a voltage applied from the DC/DC converter into an AC voltage having enough a high level that turns on a lamp.

However, the conventional inverter for a LCD raises a problem of large power consumption in that an efficiency of a transformer included in the DC/AC converter is deteriorated.

Referring to Fig. 1 and Fig. 2, a transformer for the inverter of the LCD includes a bobbin 1 wounded with a coil 2 and having a barrier rib 1a formed every constant distance, and ferrite cores 4a and 4b introduced into the center of the bobbin 1.

The bobbin 1 provided with the barrier rib 1a is molded with a plastic. The ferrite cores 4a and 4b are mixed with a fine powder such as iron oxide or manganese, etc. to be responsible for guiding a magnetic flux. Each of these ferrite cores 4a and 4b is molded into an 'E' shape, and the

centers thereof pass through the bobbin 1. The side walls of the ferrite cores 4a and 4b surrounds the side wall of the bobbin 1 wound with the coil 2. The coil 2 has a primary side and a secondary side wound at a different winding frequency in accordance with a predetermined winding ratio, and a current flows in the coil 2.

Each end of the bobbin 1 is provided with a lead pin 3. The coil 2 is wound within concave winding parts 5a, 5b and 5c between the barrier ribs 1a as shown in Fig. 3.

The coil winding parts of the bobbin 1 wound with the coil 2 are wound with a tape. After the ferrite cores 4a and 4b were assembled into the bobbin 1, two ferrite cores 4a and 4b are surrounded by an adhesive tape.

The winding parts 5a, 5b and 5c wound with the coil 2 are divided into a low voltage area, a middle voltage area and a high voltage area with having the side walls of both ends of the bobbin 1 and the barrier ribs 1a therebetween in accordance with an increase in the winding number of the coil 2.

In a transformer T of the inverter for the LCD, the winding method of the coil 2 can be seen from Fig. 4. In Fig. 4, the first round begins to be wound at the left side of the bottom within the left winding part 5a and then the next rounds are wound in a zigzag shape. After the 25 round was wound, the winding part 5b at the center thereof begins to be

wound. Subsequently, in the same manner as the left winding part 5a, the 26 round begins to be wound at the left side of the bottom within the middle winding part 5b and the next rounds are wound in a zigzag shape. Thereafter, the right winding part 5c begins to be wound and then the next rounds are wound in the same manner. Finally, the last round Lst within the right winding part 5c is wound. The last round Lst is fed back into the left winding part 5a via a return line 2c to be connected to one lead pin 3.

Such a transformer T of the inverter for the LCD has a capacitive impedance due to the barrier ribs 1a and the coil 2a going over the barrier ribs 1a and increases the capacitive impedance by the return wire 2c at the linear region in which the last winding round Lst is fed back. Since this large capacitive impedance deteriorates an efficiency of the transformer T, the inverter has very large power consumption. In real, when an output voltage of the secondary side of the conventional transformer T is measured after determining a winding ratio of the primary side to the secondary side thereof in accordance with a voltage build-up rate, it has approximately 70% of an output voltage forecasted by the winding ratio.

**[TECHNICAL SUBJECT MATTER TO BE SOLVED BY THE INVENTION]**

Accordingly, it is an object of the present invention to provide a method of winding a coil that is adaptive for reducing a power loss and a transformer having a coil wound using the same.

A further object of the present invention is to provide an inverter for a liquid crystal display that is capable of reducing a power loss.

#### **[CONFIGURATION AND OPERATION OF THE INVENTION]**

In order to achieve these and other objects of the invention, a coil winding method of a transformer according to one aspect of the present invention includes the steps of forming a coil winding part with no protrusion member at a bobbin so as to exclude an interference caused by the protrusion member from a path wound with the coil; and continuously winding the coil from one side of the coil winding part until other side thereof.

In the coil winding method, the coil is continuously wound from one side of the coil winding part until other side thereof on a zigzag basis in the oblique direction.

Otherwise, the coil is continuously wound from one side of the coil winding part until other side thereof such that the number of winding is periodically increased in the vertical direction.

The surface of the coil is coated with an adhesive so as to prevent the coil from being collapsed in the winding process.

A coil winding method of a transformer according to another aspect of the present invention includes the steps of forming a coil winding part with no protrusion member at a bobbin so as to exclude an interference caused by the protrusion member from a path wound with the coil; winding the coil for each block by a desired winding frequency to provide at least two coil blocks; and continuously arranging the coil blocks from one side of the coil winding part until other side thereof.

A transformer for driving a lamp of a liquid crystal display according to still another aspect of the present invention includes a bobbin provided with a coil winding part with no protrusion member so as to exclude an interference caused by the protrusion member from a path wound with the coil; and said coil continuously wound from one side of the coil winding part until other side thereof.

A transformer for driving a lamp of a liquid crystal display according to still another aspect of the present invention includes a bobbin provided with a coil winding part with no protrusion member so as to exclude an interference caused by the protrusion member from a path wound with the

coil; and at least two coil blocks wound with the coil for each block by a desired winding frequency and continuously arranged from one side of the coil winding part until other side thereof.

An inverter for a liquid crystal display according to still another aspect of the present invention includes push-pull switching devices provided at the DC/AC converter to alternately intermit a DC voltage; and a transformer having a primary side connected to said switching devices and a secondary side connected to said lamp and including a bobbin continuously wound with a coil from one side of a coil winding part with no protrusion member until other side thereof to build up a voltage applied from said switching devices, thereby driving said lamp.

An inverter for a liquid crystal display according to still another aspect of the present invention includes push-pull switching devices provided at the DC/AC converter to alternately intermit a DC voltage; and a transformer having a primary side connected to said switching devices and a secondary side connected to said lamp and including a bobbin continuously arranged with coil blocks wound with a coil by a desired winding frequency from one side of a coil winding part with no protrusion member until other side thereof to build up a voltage applied from said switching devices, thereby driving

said lamp.

These and other objects of the invention will be apparent from the following detailed description of the embodiments of the present invention with reference to the accompanying drawings, in which.

Hereinafter, the embodiment of the present invention will be described with reference to Fig. 5 to Fig. 14D.

Referring to Fig. 5 and Fig. 6, a transformer for a lamp driving circuit of a liquid crystal display according to the present invention includes a bobbin 11 wound with a coil 12 within a single of winding part 15 that is not provided with a barrier rib or a protrusion member, and ferrite cores 14a and 14b introduced into the bobbin 11.

The bobbin 11 is molded with a plastic. The ferrite cores 14a and 14b are mixed with a fine powder such as iron oxide or manganese, etc. to be responsible for guiding a magnetic flux. Each of these ferrite cores 14a and 14b is molded into an 'E' shape, and the centers thereof pass through the bobbin 11. The side walls of the ferrite cores 14a and 14b surround the side wall of the bobbin 11 wound with the coil 12. The coil 12 has a primary side and a secondary side wound at a different winding frequency in accordance with a predetermined winding ratio, and a current flows in the coil 12.

Each end of the bobbin 11 is provided with a lead pin 13. A winding ratio of the coil 12 is determined differently at the primary side and the secondary side in accordance with a desired voltage build-up rate. The single winding part 15 is arranged between the side walls positioned at each end of the bobbin 11 and is not provided with any barrier rib or protrusion member to be gone over by the coil 12.

A winding method in the transformer according to the present invention is as shown in Fig. 7 and Fig. 8. In Fig. 7 and Fig. 8, a winding begins with the first round at the bottom being adjacent to the left side wall of the bobbin 11 and is progressed toward the right side in a zigzag shape in an oblique line direction. Finally, the last round Lst at the upper portion of the right side wall of the bobbin 11 is wound. The coil 12 wound in this manner is connected to two lead pins 13 at the primary side and the secondary side.

The transformer wound with the coil 12 as mentioned above is installed at the DC/AC converter included in the inverter circuit of the LCD shown in Fig. 1 to generate a high voltage required for a lamp CCFL.

In the transformer according to the present invention, a winding is continuously made from the first round until the last round Lst without being interfered by any barrier rib or protrusion member within the winding space in winding the coil

12 and a return wire resulting in the linear region does not exist, so that a capacitive impedance can be minimized. An output voltage of the secondary side of the transformer according to the present invention has approximately more than 75% of the output voltage of the secondary side forecasted in accordance with a winding ratio.

Fig. 9 shows a method of winding a transformer for a lamp driving circuit of a LCD according to a second embodiment of the present invention.

Referring to Fig. 9, the transformer according to the second embodiment has a coil wound in the vertical and horizontal directions within a single of winding part 25 that is not provided with a barrier rib or a protrusion member.

A ferrite core 24 is introduced into the bobbin 22. Each end of the bobbin 22 is provided with lead pins to which the input and the output of the coil are connected. A winding ratio of the coil is determined differently at the primary side and the secondary side in accordance with a desired voltage build-up rate. The single winding part 25 is arranged between the side walls positioned at each end of the bobbin 22 and is not provided with any barrier rib to be gone over by the coil.

In a method of winding the present transformer, a winding begins with the first round at the bottom of the left

side wall of the bobbin 22 and is made upwardly in the vertical direction until the upper surface of the bobbin 22 increasing the number of winding, and thereafter is made once more in the horizontal direction. Subsequently, a coil winding is made downwardly in the vertical direction and is made once more in the horizontal direction at the bottom, and is again made upwardly in the vertical direction. In this manner, the coil is wound from the first round until the last round Lst. The coil wound as mentioned above is connected to two lead pins at the primary side and the secondary side.

It is desirable that an adhesive should be coated onto the surface of the coil so as to prevent the coil wound at the upper portion from being collapsed in the winding process because the coil is wound vertically.

Fig. 10 shows a method of winding a transformer for a lamp driving circuit of a LCD according to a third embodiment of the present invention.

Referring to Fig. 10, the transformer according to the third embodiment has a coil wound per desired block unit within a single of winding part 35 that is not provided with a barrier rib or protrusion member.

A ferrite core 34 is introduced into the bobbin 32. Each end of the bobbin 32 is provided with lead pins to which the input and the output of the coil are connected. A winding

ratio of the coil is determined differently at the primary side and the secondary side in accordance with a desired voltage build-up rate. The single winding part 35 is arranged between the side walls positioned at each end of the bobbin 32 and is not provided with any barrier rib to be gone over by the coil.

In a method of winding the present transformer, the coil is wound for each block. First, a coil winding begins with the first block BL1 positioned at the bottom of the left side wall of the bobbin 32 and is made such that the blocks are successive in a zigzag shape in the oblique direction. In winding a coil within each of the blocks 36, as shown in Fig. 11, a winding begins with the first round coil at the left bottom of the block and goes over the next block at the right upper portion of the block increasing the number of winding in a zigzag shape in the vertical direction.

An adhesive may be coated onto the surface of the coil in order to prevent the coil from being collapsed in the coil winding process.

The transformer wound with the coil in the same method as the above-mentioned embodiments is installed at an inverter as shown in Fig. 12 to thereby improve power efficiency.

Referring to Fig. 12, an inverter for driving the backlight of the LCD according to the present invention

includes a DC/DC converter 42 generating a DC voltage suitable for driving the backlight using a pulse width modulation (PWM), and a DC/AC converter 44 converting a DC voltage from the DC/DC converter 42 into a AC voltage to apply it to a lamp CCFL.

The DC/DC converter 42 makes a pulse width modulation (PWM) of the DC voltage applied from the power supply to indicate a turn-on interval and a turn-off interval of the lamp.

The DC/AC converter 44 plays a role to convert a voltage applied from the DC/DC converter 42 into a high AC voltage enough to turn on the lamp.

Referring to Fig. 13, the DC/AC converter 44 of the present inverter includes an inductor L to which a half-wave rectified voltage from the DC/DC converter 42 is applied, first and second transistors Q1 and Q2 connected in a push-pull shape and commonly connected, via resistors R1 and R2, to a first node n1, a first capacitor C1 connected to the collector terminals of the first and second transistors Q1 and Q2, a cold cathode fluorescent lamp CCFL turned on by a high AC voltage, a transformer T building up a voltage across the first capacitor C1, and a second capacitor C2 connected between a secondary side coil of the transformer T and the cold cathode fluorescent lamp CCFL.

If a half-wave rectified voltage of 12V is fed to an input terminal of the DC/AC converter 44, then it is applied, via the inductor L, the first node n1 and the first resistor R1, to a gate terminal of the first transistor Q1. A voltage at the first node n1 becomes a half-wave rectified voltage of 36V as shown in Fig. 14A. The first and second transistors Q1 and Q2 are alternately turned on by voltages applied to their gate terminals via the resistors R1 and R2, respectively. When the first transistor Q1 is being turned on, the inductor L charges a current. If the first and second transistors Q1 and Q2 are alternately turned on, then the first resonant capacitor C1 and the primary side coil are resonated to output an oscillating waveform being close to a sinusoidal wave. When the second transistor Q2 is being turned on, a current stored in the inductor L is applied to the primary side coil of the transformer T. A voltage measured between the second node n2 and the third node n3 becomes an AC voltage of 36Vp-p as shown in Fig. 14B. As the first and second transistors Q1 and Q2 are alternately turned on, the transformer T builds up a primary side voltage at a build-up rate according to a winding ratio of the primary side coil to the secondary side coil to induce it into the secondary side thereof. The built-up AC voltage has a magnitude of 1500Vp-p as shown in Fig. 14C between the fourth node n4 and the fifth node n5, and is

applied, via the second capacitor C2, to the cold cathode fluorescent lamp CCFL to radiate the cold cathode fluorescent lamp CCFL. A voltage across the cold cathode fluorescent lamp CCFL, that is, a voltage between the fifth node n5 and the sixth node n6 has a magnitude of 500Vp-p as shown in Fig. 14D.

The transformer T has the coil continuously wound from the first round until the last round without any coil going up the barrier rib and any returned coil within the coil winding part of the bobbin like the above-mentioned embodiments. The transformer T wound with coil in this manner reduces capacitive impedance, thereby lowering power consumption of the inverter as well as improving efficiency.

#### **[EFFECT OF THE INVENTION]**

As described above, according to the present invention, the coil is continuously wound from the first round until the last round within a single of coil winding part with no barrier rib and the coil return wire at the linear region is eliminated, thereby minimizing a capacitive impedance of the transformer caused by the coil going up the barrier rib and the return wire at the linear region, etc. As a result, it becomes possible to minimize power consumption and to improve efficiency. In addition, in the inverter of the LCD according to the present invention, the transformer continuously wound with coil from

the first round until the last round within a single of coil winding part with no barrier rib is installed at the DC/AC converter, thereby reducing power consumption as well as improving efficiency.

Although the present invention has been explained by the embodiments shown in the drawings described above, it should be understood to the ordinary skilled person in the art that the invention is not limited to the embodiments, but rather that various changes or modifications thereof are possible without departing from the spirit of the invention. Accordingly, the scope of the invention shall be determined only by the appended claims and their equivalents.